OLD FRACTURE OF THE TARSUS.

WITH A REPORT OF SEVENTEEN CASES.*

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In many cases of fracture of the astragalus or of the calcaneum the nature of the lesion is apparently not recognized at the time of its occurrence. Many of the patients are treated for sprain or contusion, or for fracture of the malleoli. Later their condition is often thought to be due to rheumatism.

REVIEW OF CASES OF FRACTURE OF THE CALCANEUM AND OF THE ASTRAGALUS.

Hippocrates described tear fracture of the calcaneum, and said that, when improperly treated, it often resulted in gangrene. Theodorieus, in 1546, and others following him, denied that the calcaneum was ever fractured: "Calcaneus non fragitur, quia os durum est et protectum ligamentis." "Nullo pacto calcis accidit fractura." Norris, in 1839, published the results of an autopsy on a patient who had fractured the anterior processes of both his calcanea by jumping in delirium from a third story window. Malgaigne, however, seems to have been the first to describe accurately this form of fracture by crushing force, giving it the name of "fracture par écrasement." Abel, reporting in 1878 three cases of fracture of the sustentaculum tali by direct violence, was surprised to find that he was almost a pioneer in the subject. Fractures of the anterior part of the bone are hidden from sight and from touch. This, he thinks, is the reason why they have for centuries passed unnoticed, while tear fractures of the posterior part have been recognized.

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Since 1878 many cases of fracture of the astragalus and of the calcaneum have been reported, so many, indeed, that, unlike Abel, one is surprised at the great number of workers in the field. A study of the views of various writers lets in the light on what has been an obscure subject, and seems to point the way to a more successful treatment of these injuries.

Norris[1] reports a case of a man of thirty-five, who jumped from a window while drunk. Gangrene followed, and death. The autopsy revealed "fracture of the calcaneum in two places in its anterior part." There was no displacement. The author says that it was remarkable that the most certain diagnostic sign of this accident, the drawing up of the posterior fragment by the tendo Achillis, was absent.

Abel[2] appears to have been the first to recognize the importance and frequency of crush fractures of the calcaneum, and reports three cases of fracture of the sustentaculum tali, one being compound. This last case went to autopsy. Abel gives three symptoms as characteristic: First, broadening of the heel, Second, flattening of the foot and sinking of the malleoli, especially of the inner. This is due to the fact that the breaking off of the sustentaculum tali deprives the foot of its support on the inner side. Third, immediate pain and disability. Usually the disability is so great that the patient is unable to walk a step. If in an ordinary crush fracture the fragments are much impacted, the immediate disability is not so great. The author says that most of these fractures are treated for fracture of the leg bones, or for sprains.

Bailey's[3] case of fracture of the calcaneum is more or less doubtful. The patient, a farmer of forty years, had his foot caught between the table of a threshing machine and a wagon. From the description of the case one suspects fracture of the astragalus. The treatment consisted of rest on a pillow, with no splint. One year after the injury motion was limited at the ankle.

Goyder's[4] case was a compound comminuted fracture of the astragalus, with protrusion of the external malleolus. The foot was in inversion. Through the wound the author removed the astragalus, which had been broken into numerous fragments. The foot was put up in splints and the patient recovered with a movable ankle and a useful foot. Four and one-half years afterward the foot was shorter and narrower than the other. The patient could not bear his whole weight upon the front part of it, and, in walking, planted it squarely on the ground.

Bell[5] reports two cases of compound fracture of the calcaneum both caused by a fall on the feet. Nothing is said as to the amount of resulting disability, nor of the symptoms. In one case, "the bone was completely pulverized."

Van Buren[6] presented a specimen of a calcaneum which had been excised for caries following a comminuted fracture of the anterior portion,

several weeks before. The patient had been blown up by a blast, and landed squarely on his feet when he descended. Several months later the patient was about on crutches. This was the last note on the case.

Stimson[7] showed a specimen of an old fracture of the calcaneum. The injury had taken place eight years before, probably as the result of muscular action, and the bone had united in a bad position.

Whitman[8] reports a case of a double fracture of the calcaneum, compound on the right side, which was caused by a fall of eighteen feet. Death followed on the twelfth day from pulmonary embolism. The autopsy showed the following: "Fracture of inner aspect of right os calcis immediately below the articulation with the astragalus" (*sustentaculum tali ?*). Left side, "Os calcis . . . completely smashed. The superior surface . . . firmly impacted into the surface to which the tendo Achillis is attached. This portion of the bone was also fractured in various directions. . . . The remainder of the bone was broken into several fragments."

Bishop[9] published a case of a painter, thirty-four years old, who jumped from a ladder to the ground as the ladder slipped, a distance of thirty-six feet, and fractured his astragalus, external malleolus and cuboid. The foot was in inversion, and seemed shortened on its inner border. Part of the astragalus was dislocated on the outer side of the dorsum of the foot. The deformity was reduced under chloroform. On the eighteenth day the patient died of pneumonia. The autopsy showed the following: "The astragalus was divided into two main portions by a fracture which passed obliquely backwards and inwards, and from above downwards and forwards, along the line of the interosseous ligament, which was utterly destroyed." Part of the external lateral ligament had been torn, as well as some of the other ligaments of the foot.

Humphry's[10] patient was a boy of sixteen years, who fell sixteen feet on his left foot, and fractured his astragalus. A portion of the astragalus was dislocated and could be felt beneath the skin "on the left side of the dorsum." This was reduced under chloroform with difficulty and the foot was put up in splints. After two weeks the dislocation gradually returned and caused a small slough of the skin. Chloroform was again administered, the wound was enlarged, and the displaced fragment was removed. The fragment consisted of one-half of the astragalus which had been separated by a longitudinal fracture transversing the middle of the bone. Humphry does not say what was the end result.

Gussenbauer[11] reported a tear fracture of the calcaneum. He says that fractures from this cause are very rare. He nailed the fragment on to the body of the bone, and secured a good result.

Stimson[12] in 1888 gave the results of autopsy on a case of fracture of the os calcis and scaphoid. The patient was an adult male of thirty years who jumped in delirium tremens from a height of thirty feet.

Gilchreest[13] in the same year, reported two cases, one of fracture of the calcaneum from crushing between freight cars, one of fracture of the internal cuneiform. Both fractures were compound and were operated upon with good results.

Beeson[14] described three cases of compound fracture of the astragalus, two caused by a fall on the feet, one by a blow from a mass of iron. In all three the bone was broken into a number of pieces. Beeson removed the fragments and treated the wound by drainage. The first two cases ended in amputation. The third was under treatment at the time the report was made, but looked as if it would end in the same way.

Reed[15] gives the history of four cases of fracture of the astragalus with displaced fragments, which were treated conservatively. In three of the cases the results were bad, in one, good. In all, the injury had been produced by a fall on the foot.

Betts[16] showed a photograph of a calcaneum which he had removed from a painter. The patient had fallen about fifteen feet and landed on his feet on a stone sidewalk. He was treated for ten days under a diagnosis of sprained ankle. At the end of that time, when Betts first saw him, the foot had become infected. Final amputation was done to save the patient's life. Although the photograph is not very distinct, the case would appear from the author's description to be an impacted fracture.

Bähr[17] described ten cases of compression fracture of the calcaneum, all with the same cause, a fall from a height. The diagnosis, of course, was without the X-ray. Bähr says that the characteristic symptoms of recent fracture are (1) swelling under the ankle; (2) sensitiveness over the calcaneum; (3) restriction of motion at mid-tarsal joint; (4) great pain on walking, usually located under the external malleolus and anterior to it; (5) slow recovery. The motions of flexion and extension at the ankle are free, but supination and pronation, and abduction and adduction are painful and restricted. The foot may or may not be flattened; the calcaneum may or may not be thickened and the malleoli sunk, depending upon the amount of crushing. The author considers that the fractures of the sustentaculum tali reported by Abel are rarities. The part of bone broken depends upon the position that the foot is in. Bähr advocates, in closed fractures, plaster of Paris left on for a long time. He thinks walking should not be allowed for two months. It is a mistake to put the weight of the body on the crushed, soft bone. Afterwards, massage and active and passive motion may be tried. All stiff parts are useless and painful. Bähr thinks the flat foot is of little moment. The pain is due to the weight of the body upon the distorted bone, often not fully hardened, and is especially severe where a sprain has been diagnosed, and the patient urged to walk early. Prognosis as to complete recovery is bad. Bähr reaches three conclusions: First, fractures of the calcaneum are more frequent than has been thought. Second, they are usually unrecognized and are treated as sprains, fractures of the malleoli, etc. Third, they usually cause a prolonged disability, often of a severe grade.

Bähr [18] also reported a case of old fracture of the right calcaneum. Operation was done on account of a painful swelling in the heel which was diagnosed as a bunion. A piece of bone was chiselled off, with good results.

Jones[19] described an old fracture of the astragalus and calcaneum

in a patient who had fallen from a height of thirty feet, landing on his feet. The injury was followed by immediate pain. The diagnosis had been sprain of the ankle.

Ehret[20] in a paper published in 1896, states that of the 2016 patients treated at his institute, 47, or 2¼ per cent., had fracture of the calcaneum. Of these 47 only three came with the correct diagnosis. Thirty were of the left foot, thirteen of the right, and four of both. When the right alone was broken, the injury was distinctly of that foot. When the fall was upon both feet, the right was never broken alone, but the left was broken, or both. The stubbornness of the symptoms is marked. Only five patients were discharged completely well, and these were young. The cause is a direct blow or a fall on the feet, usually the latter. The fracture is always caused by an involuntary jump or fall, never when the patient jumps down naturally, for then he probably catches a large part of his weight on the front of his sole. The fall was always from a height, never a fall over on the level. There is no relation between the height of fall and the intensity of the fracture. Ehret has never seen a pure tear fracture, though he thinks the pulling of the muscles, fasciæ, and ligaments, plays a strong part in the crush fractures. He divides all fractures into those of the body and those of the processes. Immediate disability is not invariable. Dorsal and plantar flexion may not be limited. Abduction and adduction, and pronation and supination almost always are limited, because these motions take place between the calcaneum and the astragalus, scaphoid, and cuboid. The gait is characteristic, the foot being held immovable. The patient walks always on the same part of the sole. Ehret did not notice that the patient walks on inner border, but thinks he often walks on outer. The swelling is mostly about ankles and dorsum. There is thickening about the heels and filling in at the sides of the tendo Achillis. The author lays special weight on palpation. The outer side of the bone suffers most of the crushing, because the foot on the inner side can give way, whereas on the outer side it is rigid. When the body is weighted the inner ankle sinks (Sourier and Abel). Hence after fracture the external malleolus is nearer the ground. If both sink, the outer sinks more. The foot is always flattened because one of the most important stones of the arch is injured, and yet it is supinated. More than one-half of the author's patients were flat-footed before the injury. Foot clonus is present in about one-half of the cases. Calf cramps are frequent at night, and atrophy of the calf takes place. The diagnosis is made on five points: First, cause: usually fall on sole. Second: restriction of abduction and adduction, with peculiar gait. Third: change in the contour of the heel. Fourth: broadening of the heel. Fifth: flattening of the foot. The patient must not be permitted to walk too soon, for fear of injuring the bone further. Massage, electricity, baths, gymnastics, and shoes are recommended. The restriction of supination and pronation causes most of the resulting disability. By operation any loose pieces of bone can be removed, as also the retro-Achilles bursa.

Joy[21] reported a tear fracture of the calcaneum plus comminution,

received by an intentional fall on the feet. Open operation with tenotomy was performed, but nothing is stated as to the end result.

Golebiewski[22] described a case of fracture of the scaphoid, astragalus, and calcaneum, caused by the attempt of a hod-carrier to go up a ladder in his bare feet with a heavy weight on his shoulder. In this case the diagnosis was probably wrong, as no fracture of the calcaneum appears in the skiagram. Palliative treatment attained a fair result.

Neuschäfer[23] published a case of pure tear fracture of a large piece of the calcaneum. Tenotomy did not avail to reduce the dislocated fragment. An incision was then made over the heel, and the fragment was sewn in place. The foot was put up in plaster, in strong equinus, and union was uneventful. Three and one-half months later the patient walked without a stick.

Vollbrecht[24] reported two cases of fracture of the astragalus. The patients were adult males. One sustained his injury by a fall from a horse; the other by a kick from a horse. One had been diagnosed sprain, and the other contusion.

Carless and Mayon[25] find that many of these cases of fracture of the calcaneum do badly if left to themselves. The resulting pain is due to depression of the astragalus and to formation of a large mass of callus under the calcaneum. Treatment is "somewhat unsatisfactory." In the early stages evaporating lotions are recommended. If, after swelling has subsided, the foot is in a bad posture it should be twisted back under an anæsthetic, and plaster of Paris should be applied. In an old standing case with much deformity and pain a wedge of bone may be removed, or the head of the astragalus may be excised, or even the entire astragalus.

Raven[26] reported a case of fracture of the astragalus and possibly also of the calcaneum (compare with Urban's[35] case). The patient was a male, aged seventeen, a waiter, who had fallen ten feet, landing on his left heel. Great swelling of the left foot and ankle were present. The foot was displaced inward and was inverted. There was crepitus below the internal malleolus, and a small bony movable mass could be felt. In a few hours all physical signs were obscured by the swelling. After a week's rest the deformity was partly reduced under anæsthetic, and plaster of Paris was applied. Eight weeks later the patient had a fair amount of motion and could walk fairly well. The foot still remained much thickened.

Vegas[27] published a case of fracture of the astragalus in a boy of twelve who was thrown from a horse, and had been in plaster of Paris for forty days before Vegas saw him. The foot was inverted, and motion at the ankle was restricted. Excision of the astragalus gave a good result. The writer maintained that these fractures were rare.

Bennett[28] describes a case of fracture of the astragalus, which he thinks was probably caused by a blow. The specimen was obtained from the dissecting room and was without history. There was a single line of fracture without displacement, which had united.

Villard[29] gave the result of an excision in a case of old fracture of

the astragalus. His patient walked without fatigue or limp and the equilibrium of his foot was perfect.

Galavielle's[30] case of fracture of the astragalus was evidently a linear fracture without much displacement. The patient was thrown to the ground and could not rise. There was great immediate disability. One year after the injury, flexion, extension, and lateral movements were limited. The author says that fracture of the astragalus is frequent, and is caused by direct or indirect violence. Usually it is not accompanied by displacement, and heals early and rapidly.

Heger[31] described three cases of fracture of the calcaneum, one a tear fracture, two crush fractures. The treatment of crush fracture recommended is by plaster of Paris. Union is hard to obtain.

Destot[32] reports three cases of fracture of the calcaneum, two of them recent, and two cases of fracture of the inferior extremity of the tibia and of the astragalus. All were caused by falls on the feet from a height of two to five meters. In only one case of fracture of the calcaneum was the bone badly splintered, and in this case the prognosis was better than in the others. In one case there was very little deformity and the foot was not flattened. The two fractures of the astragalus were almost exactly alike, one being two and the other twenty months old. In both the foot was in varus, and the tibio-tarsal joint was ankylosed. A piece of bone four cm. long was torn from the anterior aspect of the tibia, and the foot was subluxated forward, giving it an elongated appearance. The hollows behind the malleoli were effaced, and those below the malleoli were partly so. Both patients had a permanent deformity which would diminish in time, but at the end of twenty months one patient walked with difficulty and used a cane. He was incapacitated for work. Resection of the astragalus was the only remedy to be advised for these patients.

Destot[33] also reported a case of old fracture of the astragalus in a man of thirty-five years, who fell about three feet, and was for five months treated for sprain. During this time the patient's condition had not improved. The author inclined to resection, but the patient would not permit it. The prognosis of these fractures of the astragalus differs according to the location of the fracture and the displacement of the fragments. They are all apt to be very tedious. If one articular surface of the bone is involved, the prognosis is worse than if both are. Destot propounds the question whether it would not be better in fracture of the astragalus, realizing the tediousness and long duration of the symptoms, to do an excision at the time of injury, rather than to wait for a year or two and then probably be obliged to do the operation.

Morgan[34] published a case of fracture of the astragalus with displacement of the posterior half, caused by a severe blow upon the thigh while the knee was flexed. Nothing as to treatment or result was given.

Urban's[35] case of fracture of the astragalus with dislocation backward of the posterior half, was in a glazier of fifty years of age, who fell from a height of twenty feet. The posterior part of the bone was dislocated. The tibia was forced through the fragments and rested on the

calcaneum. No exterior wound was present. The fragments could not be replaced even under an anæsthetic. Urban therefore laid bare the ankle by an incision on the inner side, divided the three tendons on the inner side of the foot, chiselled off the lower part of the inner malleolus, turned it down with the deltoid ligament, and brought the fragments of the astragalus into position. The tendons were then sewn, the malleolus brought into its proper place, the wound was closed, and plaster of Paris was applied. The results were excellent, the patient walking without the plaster in the sixth week. Urban says that with dislocation or fracture of the astragalus, the bone or fragment must be put in its proper place even if an extensive operation be necessary. The removal of the astragalus should rarely be done.

Neuhaus[36] reported eleven fractures of the calcaneum, ten apparently from fall on the feet, one a gun-shot fracture. The prognosis depends on the amount of damage to the bone. If the bone is badly crushed and the fragments are dislocated, the prognosis is bad; otherwise it is good. For treatment he recommends baths, massage, and exercise.

In Berard's case[37] of old fracture of the internal malleolus, etc., the injury had been caused by the fall of a heavy weight on the foot fifteen years previously. The patient had gone to work ten days later and but little deformity was then present. Two years afterward an abscess appeared at the site of the old wound. The description of this case leads one to doubt the correctness of the diagnosis. The bones of the tarsus were united in a solid mass, their outlines were lost, and they were hypertrophied and deformed. Rarifying osteitis was present in the posterior tarsal bones. The bone disease was accompanied by ulceration of the skin, club foot, ascending neuritis of the post-tibial nerve, and by severe trophic disturbance. The author himself seems uncertain as to the correctness of his diagnosis. The treatment was amputation!

Bouchet[38] reports a case of crush fracture of the calcanea with the classical symptoms. The patient fell from the third story, landing on his feet. Under chloroform an unsuccessful attempt was made to replace the fragments. The author recommends lateral pressure under anæsthesia to reduce the fractures. He considers that the symptoms following them are largely due to compression of the nerves and vessels under the bone.

Rollet[39] in 1904 published the report of a case of fracture of both calcanea. The patient was a mason, thirty-two years of age, who fell from the second floor, landing on his feet. The two ankles were said to have been forced into the bony masses which lapped over on the sides, and posteriorly the axes of the astragali were changed so that their heads, instead of looking forward and downward, looked forward and upward. The body of the astragalus was forced into the body of the calcaneum. The results were given as follows: First: the patient supports his weight on a heel composed of broken splinters of bone. Second: the mid-tarsal joint is opened up and is kept in a state of inflammation. Third: the arch of the foot is depressed.

Eisendrath[40] has recently published a case of tear fracture; the treatment consisted of suturing with kangaroo tendon.

In many of the above reviewed cases in which no X-ray photographs were taken, the diagnosis would seem to have been based upon conjecture and supposition rather than upon certainty.

Author's Cases.—Judging from the history of the author's cases, seventy-six per cent. of them had been improperly diagnosed at the time of injury. Fifteen of the patients were men, one was a woman, one, a boy of fifteen. Six had a fracture of the left calcaneum, five of the right, one of both calcanea. Three had a fracture of the right astragalus, one of the left. One patient, the woman, had a fracture of both calcanea and of the left astragalus. Two of the fractures of the astragalus, and one of those of the calcaneum, were associated with a fracture of the tibia.

The history was the same in every case. All the patients had fallen from a height, usually greater than ten feet. They had been carried to their homes or to the hospital, and had been confined to their rooms from three to six weeks or more, those with fracture of the astragalus being disabled usually for a somewhat longer time than those with fracture of the calcaneum. In three other cases, which presented some of the symptoms of tarsal fracture, and which were at first regarded as possible cases, the usual history of a fall from a height, with extreme immediate disability could not be obtained. One was probably a case of syphilitic periostcitis; one was a bruise, and the other was a severe sprain. In Case II the patient gave a history of being struck by a barrel, only mentioning the fall on his feet when he was closely questioned. Case V. was treated at first with a wrong diagnosis. This patient also admitted afterward the fall on his feet. Numerous authors have taught that fracture of the calcaneum can be caused by muscular action, and that the bones of the tarsus can be fractured by various kinds of direct violence; and they are undoubtedly correct. But, on the other hand, it may be said that if a man falls from a height and lands on his feet, and if he is then unable to walk home and is confined to

his bed with great pain and swelling in his heels and in his ankles, a strong presumption, at least, of fracture of the calcaneum or of the astragalus is justified. If the patient be seen for the first time several months afterward and, besides giving the characteristic history, says also that he was confined to his bed for a month or two, and has since suffered from pain and stiffness in his heel or in his ankle; it is possible to tell almost with certainty, before he takes off his shoes, that he has a tarsal fracture, It is a great mistake to regard these fractures as rarities. They are. on the contrary, very frequent, and doubtless are responsible for much of the odium that attaches to a sprained ankle.

Cases VIII and XVII were seen at the Ruptured and Crippled Hospital; all the other cases at the Roosevelt Hospital, O. P. D.

Case I.—John Daly, aged fifteen, a schoolboy. Old fracture of left tibia and calcaneum. The patient fell about two months ago from a height of four stories, and landed on his feet. He was carried to the hospital and was confined there for six weeks. Examination shows old united fracture about two inches above the lower end of tibia, abduction of the heel, thickening about the calcaneum, and obliteration of the concavities under the malleoli. Treatment, strapping.

The X-ray shows probable fracture of sustentaculum tali.

Case II.—Thomas Breese, aged forty-nine, a carpenter. Old fracture of right calcaneum. Four months ago the patient "sprained" his right ankle by a fall on his feet from a height of twelve feet. He was carried in an ambulance to the hospital, and was confined there for three weeks. Since then he has suffered from pain and stiffness in his right foot. Examination shows the heel in peculiar abduction. The normal concavities under the malleoli are not present. The calcaneum is thickened.

The skiagram (Fig. 1) shows a probable fracture of the sustentaculum tali.

Case III.—Thomas Lacey, aged sixty years, a driver. Old fracture of the right calcaneum. Four weeks ago the patient jumped from a truck and hurt his right ankle. He reached

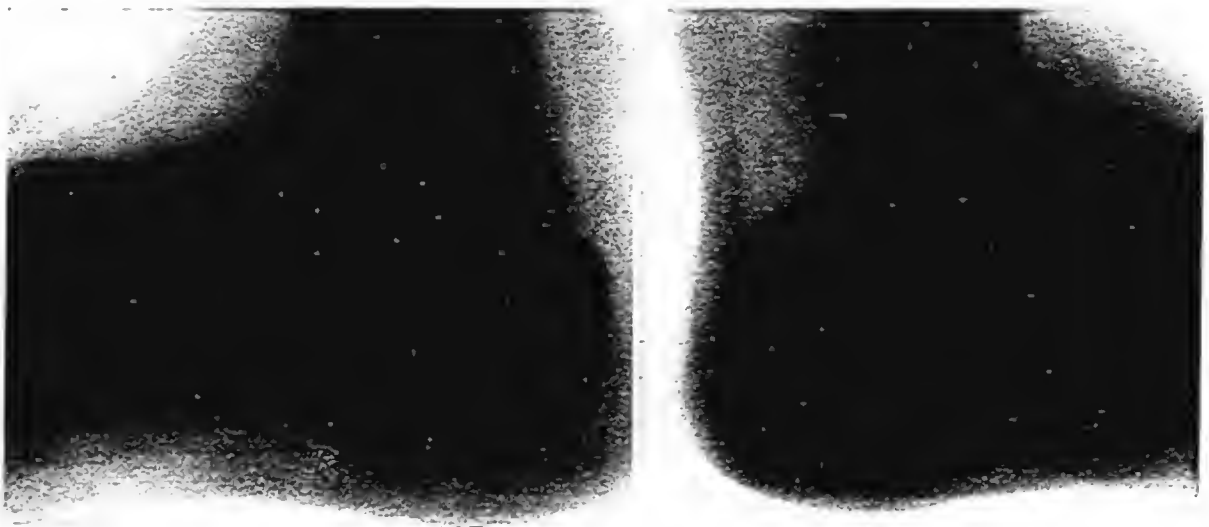

FIG. 1.—Old fracture of right calcaneum. See Case II. Normal bones of left tarsus shown for purpose of comparison.

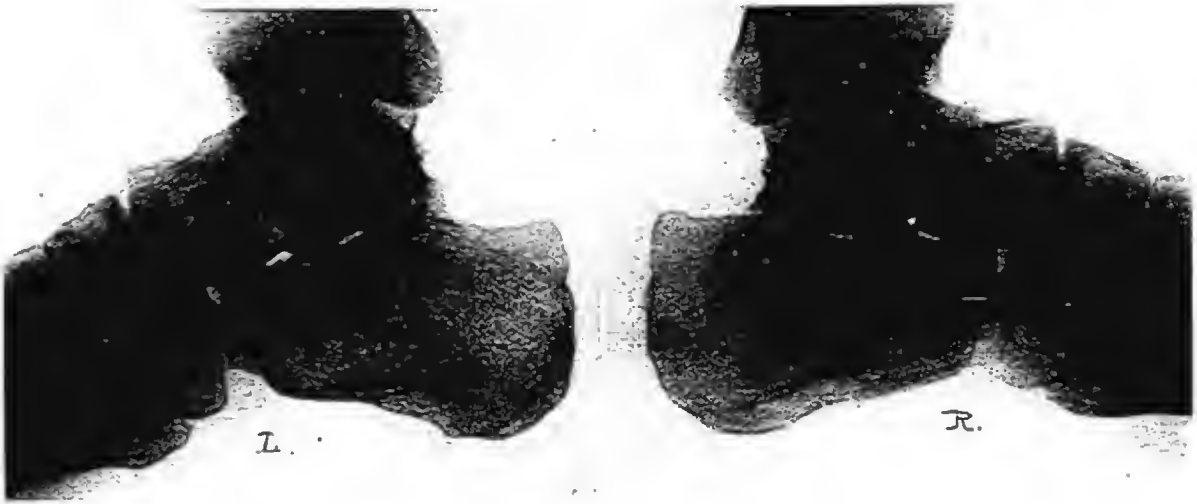

FIG. 2.—Old fracture of right astragalus and calcaneum. See Case III Normal bones of left tarsus shown for purpose of comparison.

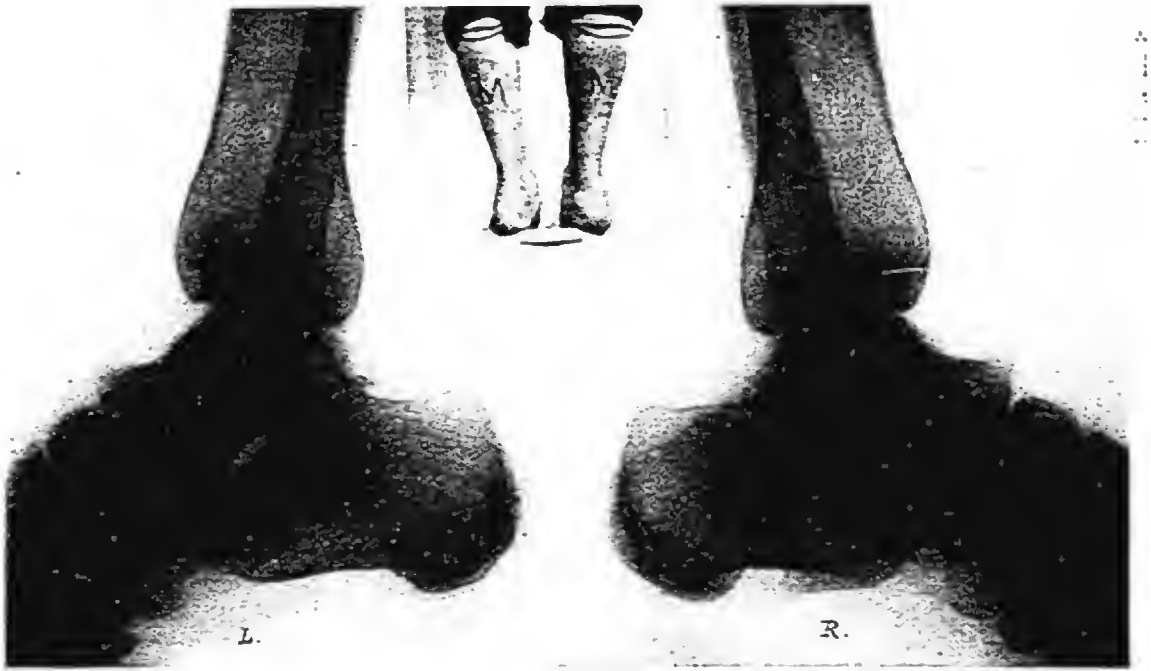

FIG. 3.—Old fracture of both calcanea. See Case IV.

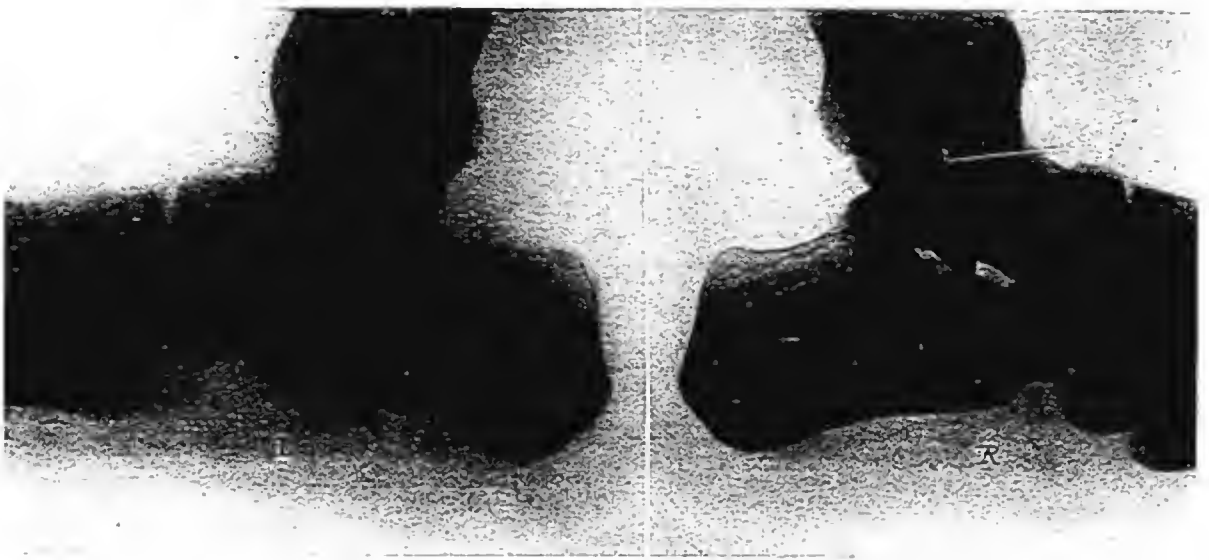

FIG. 4.—Old fracture of left calcaneum. See Case VII. Normal bones of right tarsus shown for purpose of comparison.

home with the aid of a broom for a crutch, and was confined there for four weeks. Now he suffers pain under his external malleolus and about his heel when he walks. Examination shows peculiar abduction of the heel, disappearance of hollow under the external malleolus, and thickening of calcaneum. Treatment, massage.

The X-ray (Fig. 2) shows an old line of fracture of the calcaneum through the body of the bone.

Case IV.—Whitfield Mabey, aged forty-four years, a conductor. Old fracture of both calcanea. The patient was thrown off a freight car six months ago, landing on both heels. He was carried to the hospital, and stayed there for thirty-eight days, suffering great pain. He says that both heels were swollen, and were black and blue. His injury was diagnosed sprained ankles. Since leaving the hospital the patient has been incapacitated for work. Examination shows both feet abducted; adduction painful; slight thickening is present about the heels.

The X-ray (Fig. 3) shows fracture of both calcanea, probably of the sustentaculum tali.

Operation was advised and refused. The treatment consisted of strapping and shoes. Later the strapping was removed and the heels were massaged and were soaked in hot and cold water. A Whitman brace was applied on one foot. At last notice the patient was at work, but was unable to pursue his former occupation.

Later: Patient announces that he cannot work, and has put in a claim for accident insurance on the ground of total disability.

Case V.—William Donald, aged thirty-seven years, a stonecutter. Old fracture of right tibia and fibula, and of left tibia and right calcaneum. Six weeks ago the patient's legs were squeezed in an elevator. The accident caused a compound fracture of both bones of the right leg, and a simple fracture of the left leg. The patient was confined to the hospital for four weeks and had his plaster of Paris removed this morning. Examination: Union, in good position, of the fractures of the leg bones. Thickening under external malleolus of the right foot, peculiar abduction of the ankle; motion of the ankle free. Normal hollow absent under external malleolus. Internal malleolus prominent. Patient now admits having fallen three

stories three years ago, landing on right foot. He was in the hospital fourteen weeks after the fall.

X-ray shows smashing of the calcaneum, probably true impaction.

Case VI.—Joseph Kennedy, aged forty-two years, a laborer. Old fracture of left calcaneum. Three weeks ago patient fell from a height of twenty feet, and landed on his feet. He was carried home, and has been confined to the house ever since. He says he was "black and blue" under the ankles. Examination: Patient limps; his gait appears painful. Slight thickening is present under the external malleolus of the left foot, with extreme sensitiveness to pressure. There is no marked deformity. Treatment, strapping and massage. Under this treatment the patient improved somewhat.

The X-ray shows evidences of old fracture, little more than a slight irregularity of structure of the calcaneum.

Case VII.—Frank Duberstine, aged twenty-four, a clerk. Old fracture of the left calcaneum. Two and one-half months ago patient fell one story and landed on his feet. He was carried home and was confined to his house for five weeks. During this time he suffered pain in his left ankle. He complains now of pain and stiffness. Examination shows abduction of the heel and disappearance of the hollows under the malleoli, and a thickening most marked under the external malleolus.

Later, a Whitman brace was applied and was of some benefit.

The X-ray (Fig. 4) shows a fracture of the anterior process of the calcaneum, perhaps also a slight amount of impaction.

Case VIII.—Lewis Barken, aged twenty-four years, an operator. Old fracture of the right astragalus. Three years ago the patient fell down an elevator shaft, landing on his feet. He was carried to the hospital, and was there for four months, with a diagnosis of "fracture." He says his right foot was "twisted inward." The treatment was with plaster of Paris. Since then the heel has been painful and stiff. Removal of the astragalus was advised; but the patient refused his consent.

The X-ray (Fig. 5) shows great crushing of the astragalus in the posterior part, and fracture of the tibia.

Case IX.—Christopher Cheyne, a derrickman. Old fracture of right astragalus. Ten weeks ago the patient fell one story. He was taken home in an ambulance, and was confined to the

FIG. 5.—Old fracture of right astragalus. See Case VIII.

house for seven weeks with pain and swelling in his right heel. Since then he has suffered pain on walking. Examination shows thickening and stiffness about the ankle. Dorsal flexion is limited. There is no heel abduction nor obliteration of the normal concavities. Treatment, strapping.

The skiagram shows slight irregularity of the posterior part of the bone.

Case X.—William Curran, aged fifty-six years, a boatman. Old fracture of calcaneum. The patient fell in hold of boat five weeks ago, and landed on his left heel. He was in plaster of Paris for two weeks. "They claimed something was broke." Since then he has had pain and has limped. "Something was loose in heel." Examination shows thickening over the calcaneum. Treatment, strapping and shoes. On April 19, one month later, the patient had improved, but still suffered some pain. Hot and cold water was recommended. July 25, slow improvement; very little pain.

The skiagram shows a beautiful example of impaction of the calcaneum. The astragalus is also probable damaged in its posterior part.

Case XI.—William Fried, aged twenty-seven years, a machinist. Old fracture of left astragalus. Four months ago patient suffered a compound fracture of both bones of his left leg by being struck with a barrel. He was operated on in the Roosevelt Hospital. Examination shows a linear scar on the front of the shin, and another scar on the internal aspect of the leg, abduction of the foot, and thickening about the heel, and also limitation of abduction. The patient now says that he fell down stairs and that then the barrel fell down and struck him. The astragalus can be felt close up under the internal malleolus. Extension and flexion are limited at the ankle; they come to a sudden "bony" stop. Treatment, strapping and shoes. Two months later the foot was markedly improved; the patient was at work, and had good motion in his ankle.

The skiagram shows an old fracture of the body of the bone without much displacement.

Case XII.—George White, aged thirty-nine years, an iceman. Old fracture of the left calcaneum. Patient says that he sprained his left ankle two months ago, and that since then he has suffered pain in it and has limped. The "sprain" was caused

by a fall from a height of ten feet. The patient landed on his feet when he fell. Examination shows thickening about the calcaneum, abduction of the heel, and disappearance of the hollows under the malleoli. Treatment, strapping.

The skiagram shows a slight change in contour of the calcaneum, probably a fracture of the sustentaculum tali.

Case XIII.—Edward Davey, aged forty-three years, a carpenter. Old fracture of right calcaneum. Three months ago patient fell a distance of fifteen feet and landed on his right foot. He was carried to the hospital and stayed there for over four weeks. His leg was encased in plaster for six weeks. The diagnosis seems to have been Pott's fracture. Since then the patient has suffered with pain and stiffness in his ankle. Examination shows the classical symptoms—thickening under the malleoli, obliteration of concavities, and abduction of the heels. Motion is not limited at the ankle. Treatment, strapping and shoes.

The X-ray shows fracture of the anterior process of the calcaneum, probably into several pieces.

Case XIV.—Patrick Lynch, aged thirty-six years, an electrician. Old fracture of the right calcaneum. Five months ago the patient fell about twenty feet, landing on his right heel. He was put up in plaster of Paris and went on crutches for five weeks. "They thought a bone was broken in the heel." Since then he has suffered from pain and has been disabled. Examination shows peculiar abduction of the right heel, filling out of hollows under malleoli, with thickening of the bone. Motion in the ankle joint is free. Treatment, strapping and shoes.

In the skiagram the sustentaculum tali appears to be fractured.

Case XV.—Robert Wheelhouse, aged forty-seven years, a machinist. Old fracture of right astragalus. Five months ago the patient fell from a scaffold at the height of five feet and landed on his right foot. He was carried to the hospital and was laid up for six weeks, with a diagnosis of " fracture of the ankle." Since then he has suffered pain in the ankle and has been disabled. Examination shows no peculiar abduction nor obliteration of the concavities. Bony thickening is present under the malleoli, in front of them, and behind them; and the malleoli are nearer the sole than normal. Motion in the ankle joint is

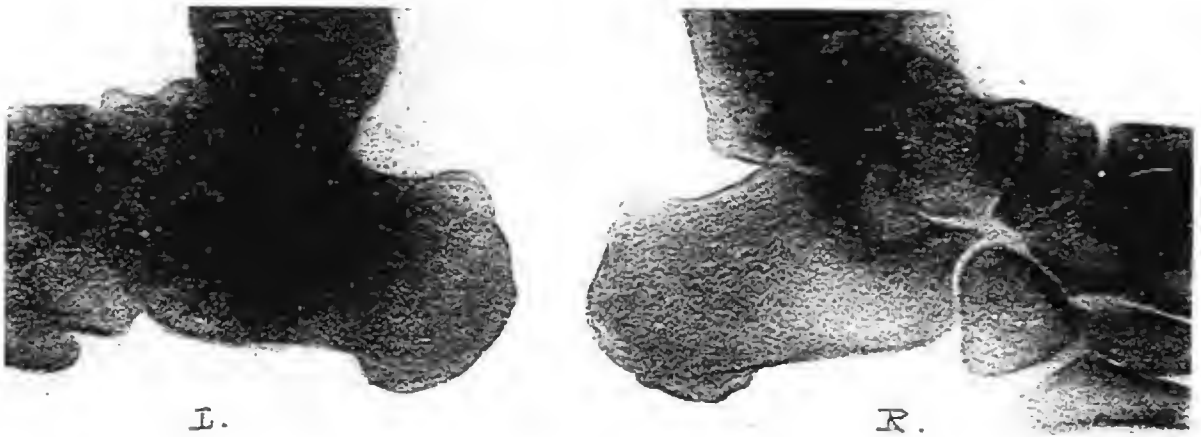

FIG. 6.—Old fracture of left calcaneum. See Case XVI. Normal bones of right tarsus shown for purpose of comparison.

FIG. 7.—Old fracture of both astragali and calcanea, with impaction. See Case XVII.

practically nil. At last accounts the patient said he was improving with massage and hot and cold water.

The skiagram shows crushing of the body of the bone with displacement of the fragments.

Case XVI.—Lorenzo Cooper, aged fifty-six years, a watchman. Old fracture of left calcaneum. Eight months ago the patient fell twenty-two feet out of a window and landed on his left heel. He was carried in an ambulance to the hospital where he stayed for four weeks, and where he was treated with plaster of Paris. Apparently the diagnosis was fracture of the astragalus. He has been lame ever since, and has suffered pain in his ankle and in the sole of his foot. Examination shows marked thickening about the heel and disappearance of the normal concavities under the malleoli, the curved line being replaced by a straight one, so that the tops of the malleoli, cannot be distinguished. No peculiar abduction can be recognized, but both feet are flat. Plantar flexion is limited; dorsal flexion is not. Treatment, strapping.

The skiagram (Fig. 6) shows impaction of the anterior two-thirds of the calcaneum; probably crushing of the astragalus also.

Case XVII.—Miss W., aged thirty-nine years, a milliner. Old fracture of both calcanea; old fracture of left astragalus. Three months ago, in delirium, the patient sprang out of a second story window, thinking that she was pursued. She landed on both feet, and was carried to the hospital in an ambulance. There she stayed for eight weeks, suffering from pain and swelling in both ankles and heels. She says her complaint was diagnosed as sprain, and that she was treated with lotions. She began to walk in the fourth week, and has since complained of pain in both heels and in her right ankle. The right foot is the more painful, and the seat of the greatest pain in this foot is in the neighborhood of the external malleolus. The patient now wears broader shoes than before her injury, though of the same length, and is compelled to use crutches. Examination at the Hospital for the Ruptured and Crippled: Both heels are markedly thickened, the left more than the right. This thickening is perceptible to sight and to touch. The normal hollows under the malleoli and at the sides of the tendo Achillis are absent in both feet. The left foot is adducted; the right foot is slightly

abducted. The outlines of the malleoli cannot be made out. Motion in the left ankle is decidedly restricted. Treatment; operation advised, but not permitted.

The X-ray (Fig. 7) shows marked impaction of the anterior portion of the calcanea, and crushing of the left astragalus.

Symptoms of Tarsal Fracture.—The most important symptom of old fracture of the calcaneum or of the astragalus is a thickening of the heel, much more easily detected if the patient presents a sound heel on the other side for comparison. The thickening can be perceived better by palpation than by inspection. Rarely is it possible to tell from the location of this thickening which bone is fractured. The malleoli are nearer the ground than in the normal foot, and their outline cannot be distinctly made out. In fracture of the calcaneum the normal concavities under the malleoli are obliterated, and their place is taken by lines more or less straight. In fracture of the astragalus motion is, as a rule, limited at the ankle. In fracture of either bone the hollows at the sides of the tendo Achillis are usually filled out. Often a peculiar abduction of the heel is present in fracture of the calcaneum, quite different from the eversion of the ordinary flat foot. This form of flat foot, characteristic of the lesion, is readily explained on the hypothesis of fracture of the sustentaculum tali, for the astragalus, deprived of its support on that side, sinks inward. We should expect then, perhaps, that the internal malleolus would be depressed more than the external, as some writers maintain to be a fact. Probably they were dealing with this form of fracture. Others say that the external malleolus usually sinks the more; but they also find that the foot is flattened. Probably these were dealing with impacted fractures in which the external part of the bone suffered the greater damage. Ehret, in maintaining the greater descent of the exterior malleolus, explains the mechanism of this impaction of the outer portion of the bone, and attempts very cleverly to reconcile seemingly

conflicting views. In point of fact, neither malleolus "sinks" more than the other, except in relation to some part of the tarsus. *As long as the bones of the leg remain intact both malleoli must sink together.* This simple fact seems to have escaped notice.

In fracture of the astragalus the foot is regularly in adduction. The interesting question suggests itself, whether this adduction in fracture of the astragalus, and the abduction in fracture of the calcaneum are merely symptoms, or whether the position which the foot is in at the time of the injury stands in a causal relation to the resulting fracture.

The skiagrams of these fractures are much more easily interpreted if both feet be included in the p cture. They are best taken from the lateral aspect. Although it is not always possible to tell by means of the X-ray the exact line of fracture, most of the author's cases of fracture of the calcaneum seem to belong in one of two classes: First, fracture of the sustentaculum tali; and, second, impaction of the body of the bone. In Case XIII the greater process seems to have been broken into several fragments. In fracture of the astragalus true impaction is not demonstrable, probably it never occurs. The bone is cracked between the calcaneum and the tibia, as is a nut in a nut-cracker. If the force continues, the bone is divided into pieces, sometimes many in number. These fragments may be displaced in various directions. The posterior portion of the bone generally sustains the greater damage. In Case VIII, with the foot in slight plantar flexion, the posterior portion seems to have been split off on the sustentaculum tali, and to have been dislocated backward. In Case XV the whole bone is, so to speak, flattened out by the impact of the tibia, again just as a nut would be crushed by a hard blow from a hammer. One of these patients with crushing of the astragalus fell from a great height, but the other only a few feet. Both patients, however, were quite stout.

Prognosis.—The prognosis of fracture of the tarsus, when treated in the usual way, namely, as a sprain or as a fracture of one of the leg bones, is distinctly bad. Most of the author's patients with fracture of the calcaneum were more or less disabled, and in not more than one case was the foot completely restored to function. It is not necessary to ascribe entirely the resulting disability to a loss of pronation and supination in the mid-tarsal joint (Ehret), though this may aggravate the symptoms. Nor do we need to accept the teachings of some of the French writers, that the trophic disturbances in the tissues beneath the heel are mostly to blame. In walking, the calcaneum bears the entire weight of the body, receiving a blow with each step; and in standing it bears a great part of the weight. The slightest change in the structure of the bone can readily cause great discomfort (Bähr). A small exostosis on its lower surface would have much the same effect as a loose stone in the heel of the boot. Again, almost invariably, except with tear fractures of the posterior part, some joint of the calcaneum is involved in the fracture, and is therefore distorted.

In fracture of the astragalus, the prognosis depends largely upon the amount of dislocation of the fragments. Cases VIII and XV of the author's series in which there was much displacement, have an absolutely stiff ankle, and are incapacitated for work. Case XI, with but little displacement, had a good result, and the patient pursues his occupation of chauffeur with little difficulty. Case IX, also without much displacement, when last seen was doing fairly well. Case XVII had a small amount of motion in her ankle, but complained of more discomfort in the foot in which the astragalus was not fractured. In none of the author's cases was the fracture compound. In compound fracture the prognosis might be different.

Treatment.—It appears from the foregoing that the treatment of these old fractures is unsatisfactory. Hot and cold baths, massage, strapping, and occasionally a

Whitman brace, may be tried, sometimes with fair results. In fracture of the astragalus with dislocation of the fragments, removal of the bone offers the only relief (Destot, Vegas, and others). In fracture of the calcaneum, with an exostosis in the sole, the protruding piece of bone can be chiselled off (Bähr).

The best results in the treatment of crush fractures are to be obtained at the time of their occurrence. With an impacted fracture of the calcaneum the impaction should be broken up if possible, and the foot should be put up in adduction and dorsal flexion. Bouchet's recommendation of lateral pressure to break up the impaction is worth trying. In fracture of the sustentaculum tali, the indication is clear; strong adduction and dorsal flexion will cause the astragalus to pull this process back into its place. The foot should be fixed in that position.

In fracture of the astragalus without displacement of the fragments, the main indication is strong dorsal flexion. When the fragments are displaced, their dislocation should be reduced, if necessary by an open operation. In this connection compare Cases VIII and XV of the author's series, in which the fragments were not replaced, with Urban's similar case, in which the ankle was opened and the dislocated portion of the bone reduced. In the first two cases the patients have a stiff ankle, in the last, Urban reports a complete recovery with a good joint. If the fragments cannot be replaced, they should be removed.

A good general rule in all tarsal fractures where the facilities for making an exact diagnosis are lacking, is to put the foot up in extreme dorsal flexion, and in inversion.

The best form of splint, after the primary swelling has subsided, is one of plaster of Paris, reaching from the bend of the knee to the toes. Under no circumstances should the patient bear any weight on his foot before the expiration of two months.

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